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AN AMERICAN DECIMAL SYSTEM OF WEIGHTS AND MEASURES

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SAMUEL RUSSELL

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STATEMENT BEFORE THE COMMITTEE ON MANUFACTURES OF THE UNITED STATES SENATE

DECEMBER 20, 1921

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WASHINGTON
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AMERICAN DECIMAL SYSTEM.

One of the primary and, indeed, imperative needs of the commerce of the United States is the establishment of a standard decimal system of weights and measures.

INHERENT DEFECTS OF THE METRIC SYSTEM.

I do not refer to the metric system which was defined by a Federal statute in 1866 and in all the intervening years has not become of any importance in the commerce of the country. The metric system has had its day in the United States. It has been weighed in the balances and found wanting. The country does not want it. The plain and inexorable fact is that the metric system is impractical, that the metric units are not of the proper magnitudes for use in commerce or in the mechanical and liberal arts, and that this defect of the metric system can never be overcome. This is the reason why the metric system has made no headway anywhere except by the compulsion of arbitrary legislation. It is an absolutely futile thing to attempt to force the commerce of a great country like the United States into a metric strait-jacket.

The decimal correlation of the units is the only merit of the metric system. The utility and convenience of a decimally related system of weights and measures is to be admitted. The processes of arithmetic are decimal. A system of duodecimal arithmetic would require 12 digits—1, 2, 3, 4, 5, 6, 7, 8, 9, X, H, O. But we have decimal arithmetic, and the decimal relation, therefore, is the most convenient relation between the units of measurement. The advantages of the decimal arrangement are exemplified by the fact that American engineers have decimalized the foot, that American mechanics have decimalized the inch, and that American physicists have decimalized the pound. The difficulty, however, is that the foot, inch, and pound are not themselves decimally correlated and therefore can not be comprised in a standard decimal system.

THE TRUE WATT SYSTEM OF MEASURES.

The fact of fundamental significance in this matter is that the cubic foot of water at maximum density weighs precisely 1,000 ounces (avoirdupois), from which it follows that we may define the ounce as the cube of the tenth of the foot of water at maximum density. This gives us a volumetric definition of the ounce and at the same time defines a new linear unit, the tenth of the foot, which we may denominate the decimal inch and from which we directly derive the decimal square and the decimal cube. This very pertinent fact was pointed out by James Watt, the great British mechanician, in 1783, and was also stated by Jefferson in 1790 in his report of a plan for establishing uniformity in the coinage, weights, and measures of the United States. Jefferson's decimalized dollar was adopted for our coinage. Jefferson's decimalized foot would have been adopted had he not proposed to change the foot to the equivalent of 11.74 English inches, defined as the fifth of the pendulum rod beating seconds.

The present plan is to decimalize the English foot. It was James Watt who had the original conception of a complete decimally related system of weights and measures, with the unit of weight and all other units derived from the unit of length, and Watt's proposal was expressly to make the English foot and the ounce derived from the tenth of the foot, the bases of his decimal system. In Watt's own langauge, "As to the precise foot, * * * the common English foot may be adopted * * * which has the advantage that the cubic foot is exactly 1,000 ounces, consequently the present foot and ounce would be retained, * * * the inconvenience of changing all the foot measures and things depending on them, would be much greater than changing all the pounds, bushels, gallons, etc. I therefore give the preference to those plans which retain the foot and the ounce. * * * Let the philosophical pound consist of 10 ounces or 10,000 grains; the ounce to consist of 10 drachms or 1,000 grains;

the drachm to consist of 100 grains. Let all elastic fluids be measured by the ounce measure of water, by which the valuation of different cubic inches will be avoided, and the common decimal table of specific gravities will immediately give the weights of those elastic fluids." Or, as it was stated by Dr. S. W. Stratton, Director of the Bureau of Standards (Miscellaneous Document No. 21), "James Watt suggested that all units of weight and measures be derived from a single unit of length. This was the basic principle of the metric system." But the metric system is only the impractical counterfeit or imitation of the real decimal system of weights and measures conceived by James Watt. The French communists appropriated Watt's decimal idea, but did not give it the practical application he had in mind. They applied Watt's idea, on the contrary, to their arbitrary meter, which they claimed was the ten millionth part of the quadrant on the meridian passing over France, but they miscalculated the actual length of the quadrant by nearly a mile. And it should be remembered, moreover, that standard measures must be convenient to the arts instead of being accommodated in some fanciful fashion to nature, in which all quantities are relative and none definite.

The meter is not what it "scientifically" pretends to be, nor is it otherwise useful in the arts as compared with the foot and its fractions which have been established by custom and have the sanction of long usage, convenience, and utility. The foot, therefore, as the base for a decimal system of weights and measures is in every way superior to the meter.

NATURAL MAGNITUDES FOR ARTIFICIAL MEASURES.

The natural magnitudes that have been proposed as bases for artificial mensuration are the great circle of the earth of which the meter of 39.37 inches is fancifully claimed to be the 40-millionth part; the second pendulum which at London is 39.1398 inches and at Washington is 39.0968 inches; the second "rod" of 58.72368 inches, one-fifth of which Jefferson proposed as the American foot which was to be decimalized to 10 inches, 100 lines and 1,000 points; and the acceleration of gravity per second, of 32.16 feet or 385.95 inches, one-tenth of which would be 38.592 inches. But while an original linear standard could be approximately accommodated to any or at least some of these "natural" magnitudes, it could not after primary determination, as a practical matter, be periodically tested or tried by these natural magnitudes. The original linear rod would be the standard to which all duplicates would be referred for comparison. In other words, an artificial, invariable metalic rod would be the standard and that is precisely what we may have in the standard foot. The foot has been determined to be .30046 of the second pendulum at London and to be .3048 of the standard meter refrigerated at Sevres. And this is quite as precise and definite as though the foot were an aliquot part of the pendulum or of the meter. The Bureau of Standards at Washington should become the repository of the New American decimal standards.

If the meter of 39.370113 inches were in any wise to be preferred to the foot, the yard of 36 inches would also be preferred to the foot. The fact, however, is otherwise. The foot is generally preferred to the yard in practice. The use of the yard has even now become limited to a few special trades.

THE FOOT, THE HISTORIC LINEAR STANDARD.

The foot has at some time been the standard linear measure of every civilized nation both of the ancient and the modern world. The foot of Egypt was equal to 12.16 English inches; the pes of Rome to 11.65 inches; the pous of Greece to 12.123 inches; the pied of France to 12.79 inches; the foute of Russia to 12 inches; the chih of China to 12.5 inches; the shaku of Japan to 11.928 inches; the fuss of Germany to 12.36 inches; the fuss of Vienna to 12.444 inches; the fot of Norway to 12.35 inches; the fod of Denmark to 12.36 inches; the fot of Sweden to 11.69 inches; the pie of Spain to 11.4 inches; the pe' of Portugal to 12.96 inches; and the pe' of Brazil to 12.96 inches. It is the English foot, however, of 12 inches as we know it, which has become the standard foot of the world.

The standard decimal rule of the foot is graduated into tenths, hundredths, and thousandths which are denoted respectively as decimal inches, lines, and points. There are a thousand points to the foot. The use of multiples of the point will in practice avoid any confusion with the common inch or its fractions. The point is about as fine a graduation as can be conveniently indicated upon a steel rule. The point is three and a third times as fine as the metric millimeter. The capacity of the point for the elimination of fractions in computations is therefore 3⅛ times as great as that of the millimeter.

The line or hundredth of the foot is as fine a graduation or unit as may be plainly numbered or figured upon a scale or rule. The numbering of the lines of the foot from 1 to 100 will permit with perfect facility the measuring directly to lines or hundredths of the foot. The line ought really to become the prime mechanical unit and should be divided by the micrometer into 100 parts for precision measurements and tolerances.

Decimal multiples of the foot may also be prescribed; the pole of 10 feet; the chain of 100 feet; and the league of 1,000 feet. This will make a mile 528 poles, a half mile 264 poles, a quarter mile 132 poles, an eighth mile (furlong) 66 poles, a sixteenth mile (20 rods) 33 poles, and a thirty-second mile (10 rods) 16.5 poles, which makes the pole readily adaptable for land measurement and surveying.

WEIGHTS DERIVED FROM THE FOOT.

The ounce, as the standard weight is defined as the decimal cube of water at maximum density and is divided into 1,000 grains as originally proposed by James Watt. It may be preferable to denote the new standard grain or thousandth of the ounce as the "mill" (m.) to distinguish it from the common grain as used in Troy weights, and until the common grain becomes obsolete. The tenth of grain might be denoted the mite as was proposed by Jefferson. The common grain, of which there are 437½ in an avoirdupois ounce is obviously an impractical fraction of the ounce and may well be supplanted by decimal fractions of the standard ounce. Scales are now offered to the trade with beams graduated to tenths, (d.) and hundredths (c.) of the standard ounce. The practical retail scale should have a beam graduated to 1,000 ounces. Modern scales with charts or dials graduated to ounces may readily have charts marked to indicate 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 ounces, etc. The ounce should become the weight unit for retail trade. The Troy ounce is now used in all denominations up to 1,000 ounces and weights in these denominations are offered to the trade. The same use should be made of the avoirdupois or new standard ounce.

Decimal weights of the ounce may, of course, be used on any balance. These decimal weights should be in mills or thousandths of the standard ounce and should be made in the following denominations: 1 mill, 1/1000; 10 mills, 1/100; 100 mills, 1/10; 125 mills, ⅛; 250 mills, ¼; and 500 mills, ½. Multiple weights of the ounce should be in denominations of 1, 2, 5, 10, and 20 ounces for use on balances, and scale poises should be made to indicate 50, 100, 200, 500, and 1,000 ounces. The 10-ounce weight might be denominated the mark, and the 100-ounce weight might be denominated the stone, as was proposed by Jefferson. James Watt himself expressly proposed a 10-ounce international pound. The pound of 16 ounces, however, although not decimal, is so well established, that this word should not be used to designate any other weight.

MEASURES DERIVED FROM THE FOOT.

The bushel as used in international commerce has already become a weight unit of 60 pounds or of 960 ounces, which is the standard weight of a bushel of wheat. Sound plump wheat, moreover, will weigh full 1,000 ounces or 62½ pounds. The bushel weight should be defined as 1,000 ounces, which will standardize the weight of the bushel as used in trade.

The farm and orchard products which were formerly sold by the bushel measure, are now generally sold in boxes, barrels, crates, hampers, baskets, or other containers which do not have any relation to the bushel measure and which for certainty ought to be defined in terms of the foot cube. The new decimal standard measure for commodities is the foot cube or tub as it is proposed to call it.

Cargo space in ships and freight space in railroad cars and in warehouses are now generally indicated in foot cubes. Water in reservoirs, or flowing in aqueducts, is now measured in foot cubes or foot cubes per second as the case may require. Gas and water from service mains are measured and sold in foot cubes. The import duty or tariff on "grapes in barrels or other packages is 25 cents per cubic foot of the capacity of the barrels or packages." The tariff duties on lemons, limes, oranges, grapefruits, shaddocks, and pomelos are also prescribed upon a cubic-foot basis (tariff act 1913, Schedule G, 219–220). The foot cube as a commodity measure has thus received the approval of Congress. The foot cube or tub is just 8 decimal cubes or ounces more than four-fifths of a bushel. The bushel measure, as long as it may be retained, ought, for the sake of uniformity and convenience, to be defined as 2,160 cubic inches, 1,250 decimal cubes, or 1¼ cubic feet. The standard bushel would then be equal to 12 by 12 by 15 inches, whereas the present American or Winchester bushel is equal to 12 by 12 by 14.9334 inches. The increase in this one dimension would be about one-sixteenth of an inch. Boxes and crates for fruit and vegetables could then be readily cut to accommodate either foot cubes or bushels.

The foot cube of wheat or potatoes would weigh full 48 pounds; a very convenient trade quantity. The tub as now used in the butter trade has the approximate volume of 1 cubic foot. The foot cube or the " tub " as it may be called, should therefore become the universal primary measure for all commodities sold by volume, and the decimal cube with its multiples the secondary unit for such purposes. The tub, which is the volume of the foot cube, would, in cylindrical form, have a base of 1,000 points diameter and a depth of 1273.2 points, and the gallon which is the eighth of the tub, would, in cylindrical form, have a base of 500 points diameter and a depth of 636.6 points. The advantage to the people of being able to visualize the quantity of an ounce by reference to the cube of the decimal inch, and to visualize the tub by reference to the foot cube is of itself a noteworthy accomplishment. The tub is divided decimally into tenths or pots, hundredths or pints, and into thousandths or decimal cubes, and binately into half tubs, pecks and gallons.

DECIMAL AND METRIC MEASURES.

The foot in the American decimal system is divided into tenths, hundredths, and thousandths, just as a meter is divided into tenths, hundredths, and thousandths; the cubic foot of water is 1,000 ounces, just as the cubic decimeter of water is 1,000 grams; and the cubic foot is made the standard commodity measure in the decimal system, just as the cubic decimeter or liter is the standard commodity measure in the metric system.

It is to be observed that in the new American decimal system it is the foot cube that is the tub and the foot cube of water that is the standard weight of 1,000 ounces; that is to say, the standard measures of volume and of mass are the cubes of the standard foot, whereas in the metric system the liter is the cube not of the standard meter but of the decimeter, and the kilogram of 1,000 grams is not the cubic meter but is the cubic decimeter of water. The decimeter itself is already obsolete. It takes no argument to demonstrate that the better arrangement is that of the new decimal system. It speaks for itself.

The physicist and chemist in the laboratory do not deal with lines but rather with volumes and weights, with units of mass and gravity. In other words, the laboratory is primarily concerned with grams and not meters. With apothecaries' weights, avoirdupois weights, carat weights, and troy weights, none of which have a volumetric definition and none of which are decimalized either in divisions or multiples, and which may be said to constitute diversion and complexity in themselves, it is easy to understand why physicists and chemists have turned with some willingness to the decimalized gram defined volumetrically as the cubic centimeter of water. But the new decimalized ounce, defined volumetrically as the decimal cube of water not only affords all the decimal perfection of the gram but is intrinsically superior as a practical weight or mass magnitude. The decimal cube is identical with the British fluid ounce of the laboratories.

The utility of the gram in chemistry arises solely because it has a volumetric counterpart, is decimalized, and is internationalized. There is not much signification in its particular magnitude, because it is the practice, even in the laboratories to use multiples of the gram and of the cubic centimeter. In general commerce, however, the gram itself is a negligible quantity and is imponderable on the ordinary trade scales. The division of the gram into a thousand milligrams may be logical in the metric sense, but is an absurdity in common sense.

The foot is a practical linear standard, the meter is not; the decimal inch, or tenth of the foot, is a simple and primary decimal division of the linear unit, the centimeter, the centesimal, or hundredth of the meter, is not; the ounce or decimal cube of water is a practical trade weight, the gram or cubic centimeter of water is not; the foot cube is a practical trade measure for commodities, the liter is not.

The metric system is, properly speaking, not a decimal, but is a centesimal system. It is commonly called the centimeter-gram system. That is what it really is. It is only the metric centimeter and its derivatives, the cubic centimeter and the gram, which are used to any extent in this country. These alone have the merit of being convenient laboratory magnitudes. Now, the third of the decimal inch is 33.3 points and the centimeter is 32.8 points, so that if we define the American centimeter as the third of the decimal inch we only increase the length of the French centimeter by half a point. If the centimeter with its derivatives, the cubic centimeter and the gram, has any special utility because of its particular magnitude, it would be equally and indeed more useful to be the precise third of the decimal inch. Three centimeters would then equal 1 decimal inch, 27 cubic centimeters a decimal cube or fluid ounce, and 27 grams an ounce. The American centimeter or "ameter" could be indicated am., the American cubic centimeter or "acube" could be indicated ac., and the American gram or "agram" could be indicated ag. The "agram" would exceed the "gram" by only three-fourths of a grain. The difference would be one-twenty-seventh of a gram. The ordinary drug and chemical balance is not sensitive below one-tenth of a gram and many balances made for the chemical trade are not sensitive below one-fifth of a gram. We could thus bring these laboratory units into correlation with the new American decimal system. The rest of the metric system, with all its entomological nomenclature, should be completely discarded in our country.

There is no use for any practical person to play with the metric conversion tables. If one wants to be a metric faddist, let him use the metric units, but there is no more sense in trying to convert our common or English measures into metric equivalents, than there is to try to convert the English language into Esperanto.

DECIMAL COINAGE.

The trade dollar defined by the act of February 12, 1873, was 420 grains troy or precisely 96 per cent of the avoirdupois ounce in weight. The present dollar of 412½ grains is 94 per cent in avoirdupois ounce in weight. The slight increase of weight required to make the silver dollar a precise ounce avoirdupois of silver 900 fine would really be imperceivable. The troy ounce of silver at 60 cents, the present market price, would coin $1.22, and the seignorage or coinage profit would be 100 per cent. At $1 an ounce troy, the profit of coinage would be 22 per cent. We ought to have a standard-ounce silver dollar with the ounce itself divided decimally into dimes (d.), cents (c.), and mills (m.), analogous to the decimal divisions of the dollar.

The standard silver dollar of 1 ounce avoirdupois in weight should be divided decimally, and the silver and minor coins should have the value of 1, 2, 5, 10, 20, 50, and 100 cents, respectively. The 20-cent coin should be called the franc or American franc. We should also denominate our $5 gold piece the pound or American pound. We would thus have 5 francs equal 1 dollar, and 5 dollars equal 1 pound. Upon this basis Great Britain and France could bring their shillings and pounds and francs into correlation with our American dollar. The silver weights of shillings and quarters should be assimilated to the fourth of the avoirdupois ounce and the silver weights of francs and 20-cent pieces should be assimilated to the fifth of the avoirdupois ounce. As these silver coins have value because of their gold redemption, the silver weights can be changed without affecting the trade value of the coins.

There remains, of course, the assimilation or correlation of the gold weights of the various national coins. This, for the sake of uniformity and the facility of foreign exchange, should be accomplished. The following table exemplifies the close approximation of the pure gold weights of the important national coins:

	Troy grains.		Troy grains.
1 dollar, United States	23.22	5 francs, Belgium	22.4
2 yen, Japan	23.148	5 francs, Switzerland	22.4
2 rubles, Russia	23.895	5 leu, Bulgaria	22.4
5 korona, Austria	23.52	5 marka, Finland	22.4
2½ guilders, Holland	23.332	5 drachma, Greece	22.4
4 krone, Norway	24.888	5 lira, Italy	22.4
4 krone, Sweden	24.888	5 leu, Roumania	22.4
4 krone, Denmark	24.888	5 dinar, Serbia	22.4
4 shillings, England	22.6	5 paseta, Spain	22.4
4 marks, Germany	22.124	5 boliver, Venezuela	22.4
5 francs, France	22.4		

It is obvious that the way to bring these coins into correlation is to bring them into aliquot relation to the American dollar. A 24-grain gold dollar would be precisely one-twentieth of the troy ounce and would make gold $20 an ounce flat. Or the assimilation of the coinage of the nations on the basis of 21.875 troy grains for the gold dollar would give a gold dollar of precisely one-twentieth of the new standard ounce or of 50 standard grains. A standard ounce of gold would be $20, and the coinage ratio with silver would be 20 to 1.

Standard gold weights for coins are only second in importance to standard uniform weights and measures.

CONGRESSIONAL DEFINITION OF DECIMAL STANDARDS.

It is perfectly obvious that the definition of these standard decimal units by an act of Congress would not be a radical departure from our present common measures, but would rather bring the same into decimal relations and afford us all the advantages of a true and complete decimal system without introducing new basic units. In practice, linear magnitudes within the foot would be indicated in points (thousandths), weight magnitudes within the standard weight would be indicated in ounces (thousandths), and weight magnitudes within the ounce would be indicated in grains (thousandths). Halves, quarters, and eighths may be precisely denoted in thousandths, and this is the practical limit for the use of binate fractions. There is no need to prescribe decimal multiples of the units. Without any specific designation of decimal multiples of our common measures, the common system is decimal in dealing with multiples. Thus lumber is sold by the 1,000 feet, flour is sold by the 100 pounds, and sugar and salt may be bought in 10-pound bags. Wheat, corn, potatoes, etc., are usually sold upon 1,000, 100, or 10 bushel orders. It is only in the field of fractions that decimalization is really required, arithmetic itself being decimal in dealing with integers or units. Such a system would be bound to make its way in the British dominions and then into Latin America, Russia, China, and Japan, and would eventually be recognized in Continental Europe. We have all the time to come before us, and we should get upon a rational and permanent measuring basis in our commerce both, domestic and foreign. We are now the greatest exporting and credit country in the world. Let the other countries take our measures and our money. It is absurd that we should go to inbred, constricted Continental Europe for our measures, weights, or money.

Goods packed for export upon an agram or ameter basis, or upon a 100 ameter (or centimeter) basis, would be quite as acceptable in South America as goods packed or required to be packed upon a metric basis, as the difference would not be discernible but with an advantage in favor of the American measures because of the slight excess in size. This would be unobjectionable and would only be a makeweight in price competition. One-half of the population of Latin America, including the West Indian Islands, is in Brazil and Mexico. None of the other Latin American countries are as important commercially or otherwise as some of the States of the Union. The Latin American countries adopted the metric fad, one after another, like a flock of sheep, in 1866, since which time the metric measures have had a scrambling application in those countries.

It is simply preposterous to propose that we change the basic weights and measures of the United States to accommodate Latin American trade. Latin America can more readily take our measures and should do so.

METRIC PROPAGANDA.

The widespread propaganda for the exclusive use of the metric system in America and Great Britain is also one of those things "made in Germany." Under date of Berlin, February 27, 1914, Sir W. E. Goschen, the British ambassador, sent this dispatch to Sir Edward Gray, London:

"I have the honor to transmit herewith a report on the establishment, under Government control of a powerful secret association for the purpose of influencing the foreign press in the interest of the German export trade and the spread of German influence generally."

This report was published by the British Government as Miscellaneous Document No. 9, September, 1914. The report deals with plans for the organization in March, 1914, of a powerful German trade and propaganda organization to be called the "Association for World Commerce."

The war intervened and of course interfered with the immediate work of this Weltverein for German trade, but only four months after the armistice, in March, 1919, the World Trade Club appeared out of the blue sky in the office of a mailing agency in San Francisco, and through this publicity agency has circularized every lawyer, doctor, merchant, chief, teacher, preacher, professor, and periodical in the United States, Canada, and Great Britain, advocating the exclusive use of the metric system in these countries. Thousands of persons signed petitions in response to these circulars. Many of these persons were of course merely metric hobbyists. Metricitis, like socialism and single-taxism, may become a mental affection. The metric crank is like the others. There is no use trying to divest him of his pet obsession. But this metric propaganda itself is just a meritricious scheme to open the markets of the United States to the metricized merchandise of Germany, and to handicap and thwart our own merchants in their own markets, in the confusion which would inevitably result from the arbitrary imposition of the metric system upon our industries and our commerce. This propaganda is procured and promoted by Dr. Albert Herbert, an ubiquitous individual, who, as stated in one of his official publications, knows North and South America "from Alaska to Tierra del Fuego; he has traded on about every island in the Pacific." The Germans favor the metric system for North America just as they favor the metric system in South America, and for precisely the same purposes.

This metric propaganda is replete with misrepresentations and false suggestions. One of its principal features is the false claim that James Watt was the founder of the metric system. The scheme seems to be to give the metric system a little British authority and respectability. To one who knows the peculiar German cerebration, this propaganda is very clearly German composition.

In one of the lurid booklets circulated by Herbert's World Trade Club and adorned with the pictures of Jefferson, Watt, and Franklin, there is published a report of the so-called American National Association of Manufacturers, signed by Albert Herbert himself as chairman, wherein it is said:

"In America Thomas Jefferson devised and submitted (July 4, 1786) a decimal system of weights and measures as good in every way as the metric. The trouble was, the then American legislators lacked the gumption to adopt it. and thus America lost the opportunity to lead the world in decimal weights and measures, though it led in decimal money by the adoption of a decimal dollar."

Jefferson proposed to divide the foot into 10 inches, 100 lines, and 1,000 points; to make the cubic foot, the bushel, and the cubic inch of water, the ounce. Even metric propagandists may tell the truth in moments when they are not conscious that it may be to their advantage to conceal the truth. The name World Trade Club has now been changed to World Metric Standardization Council. It is manned by the same hired men who were the front of the now defunct World Trade Club.

PRACTICAL DECIMAL UNITS.

There is a 4-foot mechanics' folding rule now being sold to the trade which is graduated on one side in inches and sixteenths and on the other side in tenths and hundredths of the foot. One side of this rule is marked "English"; the other side of the rule I would like to have marked "American." The catalogues of our large manufacturers of rules and tapes now show numerous tapes and rules with the foot graduated decimally in tenths and hundredths. It would be a simple matter to carry the graduations on linen tapes and wood rules down to twentieths of the decimal inch which only vary by one-fifth of a point from the sixteenth of the common inch, and to carry the graduations on fine steel rules down to thousandths or points. There is now a steel rule sold to the trade graduated in hundredths of the inch, which means 1,200 graduations to the foot.

The tenth of a point is as proper a tolerance in machine work as may be indicated by the micrometer. This minimum dimension might appropriately be denominated the mike. The millimeter is, moreover, an impractical magnitude to divide decimally for micrometric tolerances in the machine trades, the tenth of the millimeter being too coarse for a practical tolerance, and the hundredth of the millimeter being too fine for practical application or utility, even where precision measurements are required. Machine bolts which are now made to sixteenths of the inch could as well be made to twentieths of the decimal inch, with numbers running from 1 to 20, No. 1 having a diameter of one-twentieth, No. 2 of two-twentieths, No. 3 of three-twentieths, etc., of the decimal inch. The standard pitch for screw threads of eight to the inch is as 1 to $10\frac{5}{12}$ points and may well be assimilated to 1 to 10 points, and be denominated as 10-point pitch. A new system of point pitches may be worked out. Wire and wire gauges should be defined and denoted in points.

The common inch will doubtless be retained for an indefinite time as a line and dimension measure in the mechanical and machine trade. The decimal divisions of the inch as employed in shop practice are exactly convertible into terms of the new decimal system, whereas they are not convertible with exactness of facility into terms of the metric system. But the cubic inch, having no proper relation to weights, ought in practice to be abrogated in favor of the decimal cube as a volumetric, capacity and mass measure, and the square inch should likewise give way to the decimal square for measuring planes and surfaces.

The foot is now the prime line unit for engineering, surveying, construction, and general application; the yard is the prime line unit of special application in textile trades; the inch is the prime line and dimension unit in the mechanical and machine trades; and the centimeter, or, rather, the cubic centimeter or gram, is the prime mass unit of the laboratories. There is a special yard system limited to the textile trades, a special inch system limited to the machine and mechanical trades, and a special centimeter system limited to the volumes and masses used in laboratory practice which are uniformly but samples or examples of small magnitude. These special systems may stand in their limited fields of application, but they will all, in the new decimal system, have an aliquot relation to the primary foot standard, including the centimeter, which is to be defined, under the name "ameter," as the third part of the decimal inch, thus bringing it also into aliquot relation to the standard foot without materially altering its magnitude. Order will thus be brought into the whole range and field of practical and scientific mensuration by the complete correlation of all units in or to the standard decimal system.

It is not proposed to interfere by legal interdiction with any of the common or customary measures. It is to be expected, however, that some of these will go into progressive obsolescence. It is only proposed to evolve a practical and correlated decimal system of weights and measures from our present common units for the accommodation of our commerce, industries, and manufactures. The people would be free to use the foot decimally, duodecimally, or binately, according to their own preference and convenience.

We already have the basic decimal units—the foot and the ounce. They are established by custom and by the laws of the States. We will have the foot as the basic linear measure for all time to come. Why, then, should we not increase and facilitate its utility by decimalization? There is no reason why we should not; there is every reason why we should do so. It is too late to abolish the foot; it is not too late to decimalize it. Congress has the constitutional power and the duty to fix the standard of weights and measures for the United States. Congress has never exercised this power. The demand of the day is that Congress establish a standard decimal system of weights and measures for the whole country. There is no other practical way to bring order into the measures employed in our domestic and foreign commerce. The new system would accommodate our commerce and could be put into actual use with facility. It only needs to be defined by a Federal law. Its general acceptance will follow without legal compulsion or penalties, but upon its intrinsic merit and the free will of the people of the country.

THE DECIMAL STANDARDS BILL.

The bill to establish a standard decimal system of weights and measures for the United States is appended hereto.

Section 1 comprehends the basic units of the proposed decimal system, the essential units of which are the foot, decimal inch and point, the decimal square, and the decimal cube.

Section 2 defines the standard weight—the standard ounce, the standard grain, and intermediate decimal weight units.

Section 3 makes the foot cube (tub) the standard measure for commodities. The cube measure is divided decimally into pints, fluid ounces or decimal cubes, and drams, and binately into halves, quarters, and eighths.

Section 4 brings the centimeter, cubic centimeter, and gram into correlation with the decimal inch.

Section 5 defines engineering and scientific units in which the weight or mass factor is to be standard weight instead of the pound. The prefix "petty" might be used before these units to indicate that the weight employed is the ounce instead of the standard weight of 1,000 ounces. The pound itself has no decimal relation to any other weight unit, and not being an integral part of the decimal system is not adapted as a factor in standard scientific decimal units. The bill does not define new electrical measures. It is believed, however, that electricity, both for lighting and for motors, should be sold in the power units defined in the bill. It is certain that new intensity, resistance, and energy units may be formulated with copper as the metal of resistance, with the ounce as the weight factor, and the dimension factor stated in points, which will be more practical than the present international volts, ohms, and amperes. But this problem is remitted to the electrical technicians.

Section 6 defines the important common measures in terms of the decimal standards, and also gives these common measures Federal recognition and confirmation.

Section 7 provides for a prototype foot to be derived from the British imperial yard, thus bringing the new American decimal system into correlation and agreement with the measures of the British Empire.

Section 8 repeals the law expressly authorizing the use of the metric system, but does not in anywise interdict the use of the metric system, but leaves the same in the status of legal toleration instead of express authorization.

Section 9 defines the meter as the equivalent of 39.370113 common inches, in agreement with the value of the meter as fixed by the British Board of Trade, thus destroying the captious contention of metricists that the American inch and the British inch are not identical.

Section 10 provides that the act shall go into effect on the 1st of January next following its approval.

A BILL To establish a standard decimal system of weights and measures for the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the primary linear standard for the weights and measures of the United States shall be the English foot as commonly used and established as a measure of length in the United States of America and in the British Empire.

The standard decimal graduations of the foot shall be the tenth, which shall be denoted the decimal inch; the hundredth, which shall be denoted the line; and the thousandth, which shall be denoted the point.

The square of the foot shall be denoted the foot square; the square of the decimal inch shall be denoted the decimal square; the square of the line shall be denoted the petty square; the cube of the foot shall be denoted the foot cube; the cube of the decimal inch shall be denoted the decimal cube; and the cube of the line shall be denoted the petty cube.

The pole is ten feet; the chain is one hundred feet; and the league is one thousand feet.

Sec. 2. That the standard weight shall be the weight of the foot cube of water at maximum density; the standard ounce is the thousandth part of the standard weight or the weight of the decimal cube of water at maximum density; the mark is ten ounces; and the stone is one hundred ounces.

The decimal graduations of the ounce are the tenth, which shall be denoted the dram; the hundredth, which shall be denoted the carat; and the thousandth, which shall be denoted the standard grain.

Sec. 3. That the standard measure for commodities shall be the tub, which is the volume of the foot cube. The common divisions of the tub are the half, which shall be denoted the half tub; the quarter, which shall be denoted the peck; and the eighth, which shall be denoted the gallon.

The fluid ounce is the volume of the decimal cube; the pint is ten fluid ounces; and the pot is one hundred fluid ounces. The decimal graduations of the fluid ounce are the tenth, which shall be denoted the fluid dram; the hundredth, which shall be denoted the scruple; and the thousandth, which shall be denoted the petty cube.

The capacity of all containers in which either liquid or dry commodities are packed for measure or sale by volume shall be indicated for liquids in tubs, pints, or fluid ounces, and for dry commodities in tubs or decimal cubes.

SEC. 4. That the American centimeter, or ameter, is the third part of the decimal inch and may be designated am.; the American cubic centimeter, or acube, is the twenty-seventh part of the decimal cube and may be designated ac.; the American gram, or agram, is the twenty-seventh part of the ounce and may be designated ag.; and the American liter, or aliter, is the volume of one thousand acubes and may be designated al.

SEC. 5. That the water flow unit is the flow of one foot cube of water in one second of time.

The work unit is the work required to raise one standard weight the height of one foot.

The power unit is the power required to raise one standard weight the height of one foot in one second of time.

The thermal unit is the heat required to raise one standard weight of water one degree of the scale of the Fahrenheit thermometer.

The pressure unit is the pressure of one standard weight upon the surface of one decimal square.

SEC. 6. That the common inch is the twelfth part of the foot; the yard is thirty-six inches; the fathom is six feet; the rod is sixteen and one-half feet; the furlong is forty rods; and the mile is three hundred and twenty rods or five hundred and twenty-eight poles.

The acre is one hundred and sixty square rods.

The pound is sixteen ounces; the ton is two thousand pounds, or thirty-two standard weights; the quarter is five hundred pounds, or eight standard weights.

The bushel measure is the volume of one thousand two hundred and fifty decimal cubes.

The quart is the volume of thirty-two decimal cubes.

The enumeration of the foregoing common measures shall not be construed to forbid the use of other common measures not defined in this act.

SEC. 7. That a standard foot bar derived from the imperial standard yard in the National Physical Laboratory at Teddington, England, and deposited in the Bureau of Standards, shall, at the temperature of sixty-two degrees Fahrenheit, be the prototype foot and the base of the measures and weights defined in this act.

SEC. 8. That section 3569 of the Revised Statutes is hereby repealed.

SEC. 9. That section 3570 of the Revised Statutes is hereby amended to read as follows:

"SEC. 3570. The meter is the equivalent of 39.370113 common inches, which equivalent shall be recognized in the construction of contracts and in all legal proceedings for establishing in terms of the weights and measures of the United States, the value of the weights and measures of the metric system."

SEC. 10. That this act shall take effect on the 1st day of January next following its approval.

A BILL To amend sections 3513 and 3515 of the Revised Statutes, prescribing the weights of the silver and minor coins of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That sections 3513 and 3515 of the Revised Statutes be, and are hereby, amended to read as follows:

"SEC. 3513. The silver coins of the United States shall be the dollar; the half dollar, or 50-cent piece; the franc, or 20-cent piece; and the dime, or 10-cent piece. The weight of the dollar shall be one ounce avoirdupois of silver, nine hundred fine; the weight of the half-dollar piece shall be one-half of an ounce avoirdupois of silver, eight hundred fine; the weight of the franc shall be one-fifth of an ounce avoirdupois of silver, eight hundred fine; and the weight of the dime shall be one-tenth of an ounce avoirdupois of silver, eight hundred fine.

"SEC. 3515. The minor coins of the United States shall be the nickel, or 5-cent piece; the penny, or 2-cent piece; and the half penny, or 1-cent piece. The weight of the 5-cent piece shall be one-tenth of an ounce avoirdupois of an alloy of copper and nickel, three-fourths copper and one-fourth nickel; the weight of the 2-cent piece shall be one-tenth of an ounce avoirdupois of an alloy of 95 per centum copper and 5 per centum of tin and zinc, in proportions determined by the Director of the Mint; and the weight of the 1-cent piece shall be one-twentieth of an ounce avoirdupois of an alloy of 95 per centum of copper and 5 per centum of tin and zinc, in proportions determined by the Director of the Mint."

American decimal system tables.

LINES.

10 points----------1 line.
10 lines-----------1 decimal inch.
10 decimal inches--1 foot.
10 feet------------1 pole.
10 poles-----------1 chain.
10 chains----------1 league.

WEIGHTS.

10 grains----------1 carat.
10 carats----------1 dram.
10 drams-----------1 ounce.
10 ounces----------1 mark.
10 marks-----------1 stone.
10 stones----------1 standard weight.

MEASURES.

10 petty cubes-----1 scruple.
10 scruples--------1 fluid dram.
10 fluid drams-----1 fluid ounce.
10 fluid ounces----1 pint.
10 pints-----------1 pot.
10 pots------------1 tub.

Lines.	Weights.	Measures.
Point .001	Grain	Petty cube (line cube).
Line .01	Carat	Scruple.
Decimal inch .1	Dram	Fluid dram.
Foot 1.	Ounce	Fluid ounce (decimal cube).
Pole 10.	Mark	Pint.
Chain 100.	Stone	Pot.
League 1,000.	Standard weight	Tub (foot cube).

Any of these measures may be tested or determined by the volume of the corresponding weight of water.

There can be no valid objection to the enactment of the decimal bill. It is to be expected that metric partisans will make captious objection to any legislation which does not promote the impossible metric hobby, but they have really not the right to object to the improvement of our present system of common weights and measures. The metric system is now defined by section 3570 of the Revised Statutes of the United States. The decimal bill does not affect this section of the statutes, nor interdict the voluntary use of the metric system. There should be no further Federal legislation enacted upon the subject of the metric system.

The decimal bill is definitive and directory. It prescribes no penalties. Surely Congress commanded by the Constitution to establish standard uniform weights and measures for the United States, ought to do as much for our common measures as it did for the metric system by the act of 1866; that is to say, to define, decimalize, and standardize our customary measures for the commerce of the country.

EXCERPTS FROM CORRESPONDENCE BY MR. RUSSELL DISCUSSING MEANS FOR THE SIMPLIFICATION AND COORDINATION OF OUR COMMON SYSTEM OF WEIGHTS AND MEASURES.

DECEMBER 6, 1921.

C. C. STUTZ, *Secretary American Institution of Weights and Measures,*
115 Broadway, New York City.

DEAR MR. STUTZ: I know that you fully comprehend the plan I have in mind to decimalize the foot and to derive the other weights and measures from the foot. New prototype standards will have to be provided. The plan may be epitomized as follows:

A standard foot divided into 1,000 points; a standard cylindrical measure holding the volume of a foot cube, and divided into 1,000 fluid ounces (decimal cubes); and a standard weight equal to the foot cube of water at maximum density and divided into 1,000 ounces, the ounce in turn to be divided into 1,000 grains.

Decimalization of the units by thousandths will perfectly accommodate the binate fractions, halves, quarters, and eighths and the decimal fractions tenths and hundredths. The completion of the plan would likely require that some of these fractions be given special denominations.

Decimalization upon the yard would be impracticable and would be but a poor imitation of the metric system. Decimalization upon the inch would be impossible because neither the inch nor its decimal multiples would have any simple relation to the higher linear units, the foot, yard, fathom, rod, furlong, and mile. Decimalization upon the foot is the only basis which can perfectly accommodate the situation both as to weights and measures. This would perfectly meet the metric contention as to decimalization, as to the corelation of the units of mass and capacity, with the unit of length, and as to standardization, assuming, of course, that the foot would be legally standardized. Standardization of the foot, therefore, is the only solution of the problem. The standard foot will comprehend the inch and every other decimal or common fraction of the foot and thus permanently establish the inch as a part of our system of mensuration.

I am not contending for an exclusive decimal system. I believe that we ought to recognize and employ decimal duodecimal and binate fractions of the foot as may best comport with the convenience of trade, fabrication and mechanics. It would be unnecessary and indeed undesirable to restrict ourselves to decimal fractions.

There ought to be the utmost liberty in the use of so-called common or vulgar fractions, every person to accommodate his own convenience in the matter of the division of the foot.

The duty is imposed upon Congress by the Constitution "to fix the standard of weights and measures." This duty ought not longer to be delayed. If we can get the standard foot and its corollary measures established by law, the problem will be finally settled, and an end would be made of the agitation to adopt the impossible and impractical metric system. Mere negation and opposition will not suffice. The problem of standardization, decimalization and corelation must be met and satisfied, and the way is plain in adopting the standard foot as the basis of our legal system of weights and measures.

With kind regards, I am,

Yours, very truly,

SAM'L RUSSELL.

DECEMBER 6, 1921.

THEODORE ALTENEDER & SONS,
1217 Spring Garden Street, Philadelphia, Pa.

DEAR SIRS: I inclose my check for $2 for which please send me two boxwood scales of the foot, 1000ths to 10 by 1000ths to 100; one a flat scale as shown in figure 1 and the other with opposite bevels as shown in figure 2.

I desire to determine which style I like the best, as I shall require a quantity of scales in this form, with the words "decimal scale of the foot" imprinted thereon.

Very truly, yours,

SAM'L RUSSELL.

NOVEMBER 8, 1921.

Hon. S. W. STRATTON,
Director Bureau of Standards, Washington, D. C.

DEAR MR. STRATTON: I desire to procure for demonstration before the Senate Committee on Manufactures three cylindrical measures:

(1) To have an inside diameter of 13.536 inches (one square foot) and an inside depth of 15 inches, to hold a bushel of 1¼ cubic feet.

(2) To have an inside diameter of 12 inches and an inside depth of 15.28 inches, to hold the volume of 1 cubic foot.

(3) To have an inside diameter of 6 inches and an inside depth of 7.64 inches to hold one-eighth of a cubic foot or a gallon of 125 British fluid ounces.

I desire to be advised as to whether these measures could be made up in the shop of the Bureau of Standards, and as to whether you would want a request from the chairman of the committee for the same.

Kindly let me know just what may be done.

Very truly, yours,

SAM'L RUSSELL.

NOVEMBER 25, 1921.

Hon. S. W. STRATTON,
Director Bureau of Standards, Washington, D. C.

DEAR SIR: I have your letter of November 23.

* * * * * * *

I think that our commodity measures ought, for the sake of uniformity, simplicity, and convenience, be brought into simple relation to the cubic foot. They would then be easily comprehended. Accordingly, the bushel, as a volume measure, should be defined as 1¼ cubic feet, and as a weight measure should be fixed at 1,000 ounces, or the weight of the foot cube of water. And the gallon measure for dry commodities should be one-eighth of a cubic foot, or one-tenth of the bushel measure. Liquids, on the other hand, should be sold in decimal or other multiples of the fluid ounce, which as a measure of volume should be defined as the cube of the tenth of the foot. Inasmuch as a cubic foot of water weighs 1,000 ounces, the specific gravity of any substance applied to the cubic feet of its volume would give the weight in thousands of ounces. These advantages could all be realized by adopting the volume of the cubic foot as our primary measure for commodities, and by bringing our other commodity measures into simple relation to it.

Yours, very truly,

SAM'L RUSSELL.

SEPTEMBER 17, 1921.

HENRY TROEMNER, Esq.,
Philadelphia, Pa.

DEAR SIR: I received your catalogues in this morning's mail, for which I thank you. I find on page 115 a set of weights, No. 504, of the ounce and fractions down to one-eighth, which I would like you to send me. By reference to the price list, page 15, I find that the price of this set is $2, for which I inclose my check. I also want the little aluminum disks of the tenth, hundredth, and thousandth of the ounce, which you showed me. I do not recall the price, but I will remit the same upon receipt.

The plan I have in mind, which is embodied in the bill now pending before Congress, is to decimalize the avoirdupois ounce. The grain really belongs to the troy ounce and has no proper part in an avoirdupois system. The avoirdupois ounce should therefore be divided into thousandths, which may be called mills, and fractional weights should be prepared as follows:

1 M	0.001	
2 M	.002	
5 M	.005	
10 M	.010	(1/100)
20 M	.020	(1/50)
50 M	.050	(1/20)
100 M	.100	(1/10)
125 M	.125	(1/8)
200 M	.200	(1/5)
250 M	.250	(1/4)
500 M	.500	(1/2)

Multiple weights of the avoirdupois ounce should be provided in the denominations of 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1,000 ounces; in other words, it is the intention to use the multiples of the avoirdupois ounce precisely as multiples of the Troy ounce are now used. The avoirdupois pound of 16 ounces is not decimal and therefore can not be a part of the system of decimalized avoirdupois ounce and weights.

Yours, very truly,

SAM'L RUSSELL.

SEPTEMBER 24, 1921.

HENRY TROEMNER, Esq.,
Philadelphia, Pa.

DEAR SIR: * * * In my letter of the 17th I discussed briefly the advantages of decimal fractions of the avoirdupois ounce over the use of grains for the measurement of fractional parts of the ounce. The advantage and facility of using one-thousand ounce units (equal to the weight of a cubic foot of water) for the measurement of the greater weight quantities is illustrated by the following table:

	Ounces.		Ounces.
1 ton (2,000 pounds)	32,000	⅛ ton (250 pounds)	4,000
½ ton (1,000 pounds)	16,000	1/16 ton (125 pounds)	2,000
¼ ton (500 pounds)	8,000	1/32 ton (62½ pounds)	1,000

I think that the standard bushel, or rather bushel weight, should be defined as the weight of 1,000 ounces avoirdupois. In any event, the thousand-ounce unit should be defined by law and given an appropriate name.

The decimalization of the ounce in this manner would give us all the decimal advantages of the metric weights, and give us units of much greater practicality than the metric units, and, moreover, would not introduce anything new or incongruous into the system of common or avoirdupois weights. It is not the intention to interfere by law with the use of the pound, although the pound would not be a part of the decimal system. The weight units in this system would be the mill, the ounce, the bushel-weight, and the ton.

I will place your letter of September 16 on file, and if occasion requires I will order some of the larger multiple ounce brass block weights.

Yours, very truly,

Saml. Russell.

November 7, 1921.

Toledo Scale Co.,
Toledo, Ohio.

Gentlemen: I have your letter of November 4th.

I think you will agree that the common grain, of which there are 437½ in an avoirdupois ounce, is an utterly impractical fraction of the ounce, and that the division of the ounce decimally into tenths, hundredths, and thousandths would be of great practical convenience, where fractions of the ounce are to be used. But this is not a matter which concerns the retail trade very much, because it deals with multiples, rather than fractions, of the ounce.

Aside from any act of Congress on the question, I think that it would be much more convenient to sell articles, such as candy, for example, by multiples of the ounce than by fractions of the pound. It is only suggested that the decimal multiples of the ounce for small weights would be more convenient in practice, particularly for sales of fractions of the pound. It would be a simple matter to try this out with your 5-pound scale; that is to say, to mark your chart, which is already graduated to ounces, to indicate 10, 20, 30, 40, 50, 60, 70, and 80 ounces, with the intermediate 5-ounce line also staggered and marked 5. * * * It would not be much of an experiment to try this decimal chart out on your 5-pound scale, or to have it available for any user of your scale who might desire to have it.

Yours, truly,

Sam'l Russell.

November 5, 1921.

L. S. Starrett Co.,
Athol, Mass.

Gentlemen: I have your letter of November 3, together with your catalogue, for which I thank you.

I note that you offer several engineer's tapes graduated to tenths and hundredths of the foot. What I desire to obtain is a decimal rule of the foot graduated to tenths, hundredths, and thousandths. This would only require the application to the tenth of the foot, of the same graduation which you provide for the inch, in the rules which you graduate to the hundredths of the inch. The intervals between the fine graduations would be 0.012 inch in place of 0.010 inch, the effect of which would be to reduce the ultimate graduations from 1,200 to 1,000 on one of your spring-tempered foot rules.

I would only want graduations on one side of the rule, one edge as indicated and the other edge the same, except that the graduations below 0.02 would be eliminated. I would really like to see your company add a standard decimal rule of the foot to your comprehensive list of rules and tapes. I think if the same were catalogued that a sale for the rules might be gradually developed.

* * * * * * *

Very truly, yours,

Sam'l Russell.

OCTOBER 28, 1921.

Mr. A. M. TRAVERS,
*Legislative Service Bureau,
The Merchants' Association of New York,
New York City, N. Y.*

DEAR SIR: I am sending you herewith two copies of Senator King's bill, S. 2856, to establish a decimal system of weights and measures for the United States.

It is the purpose of the bill to make the cubic foot the measure for commodities sold by volume. That will give us a certain and comprehensible volumetric standard for fruits, vegetables, and other like commodities. The cubic foot is a little more than four-fifths of the present bushel and, of course, is in every wise superior to the liter as a convenient commodity measure. The cubic foot of water is precisely 1,000 of our present fluid ounces and precisely 1,000 avoirdupois ounces in weight. There is, therefore, the same relation between the ounce and the cubic foot as between the cubic centimeter, or gram, and the liter. It was this fact which gave James Watt his original conception of a decimalized system of weights and measures, with all measures and weights derived from the single linear standard, the foot.

It has been widely, but falsely, claimed that James Watt was the inventor of the metric system. This is not true. The inclosed bill comprehends precisely the original decimal system of James Watt. The standard foot is divided decimally into 1,000 points; and the standard ounce is divided decimally into 1,000 mills, thus doing away with grain weights in connection with the avoirdupois ounce. Four hundred and thirty-seven and one-half grains equal an ounce avoirdupois, which need only to be stated to demonstrate that the grain is an utterly impracticable fraction of the ounce.

The bushel weight is defined as 1,000 ounces, which is equal to 62½ pounds—the weight of a sound bushel of wheat. This arrangement, which is based on existing units in our common system of measures, will give us all the advantages of decimalization afforded by the metric system, will accommodate itself perfectly to decimal computations, and is otherwise 100 times more practical in the magnitudes of the units than is the metric system. It need only to be defined by an act of Congress to go into use immediately.

Congress defined the metric weights and measures in 1866. It is claimed by metric propagandists that a person can gain a knowledge of the metric system in 15 minutes. We have taken 55 years to find out that the country does not want the metric system and will not have it. It is perfectly a fatuitous thing to attempt to force the commerce of a great country like the United States into a metric strait-jacket. It is like attempting to use a child's toy wagon as a truck to carry freight; it simply can not be done.

English law, English language, and English measures, the common heritage of our people, exist without the force of any statute; and they cannot be abolished by arbitrary legislation. We have already had too many continental isms imported into the country. The initiative and referendum, bolshevism, socialism, and metricism are among them.

It would be a great deal more sensible to forbid the use of the metric system in the United States than to propose to abolish our common measures by arbitrary law. There is no room in the country for two systems.

Yours truly,

SAM'L RUSSELL.

SEPTEMBER 27, 1920.

J. R. BENTON,
*Dean, College of Engineering,
University of Florida, Gainesville, Fla.*

DEAR SIR: * * * I take the view that we should have an American decimal system of weights and measures. Our engineers have long since decimalized the foot for their purposes, and one may purchase from manufacturers of engineering tapes, tapes, and rules graduated in feet and tenths and hundredths of the foot. The mechanics have decimalized the inch for their purposes, and the mechanical trades are almost unanimously set against the introduction of the metric system. In short, they will have none of it; and this is true of both the British and American mechanics and mechanical interests. The commercial, industrial, and mechanical activities and interests, which are based upon our customary units of measure and weight, including as they do those of North America, the British Isles, and the British colonies, not to speak of Russia, China, and Japan, so far transcend in volume and importance those of the Latin continental countries and Latin America that it is altogether unwarranted to speak of the metric system as an international system. There are no countries in Latin America which are equal in commerce to a number of our American States.

Neither Brazil nor the Argentine can be compared with States like New York or Pennsylvania, and the other Latin American countries rank far below the average of our American States in population and commerce. Moreover, the Latin American countries have a preponderance of native population which has little or no development in culture and the arts, and whose customs or desires are not to be considered in comparison with those of our country and the British Empire.

The metric system was defined by a Federal statute and legalized for use in the United States in 1866; and in more than 50 years intervening since that time has made no progress except in the laboratories. At the same time, the Latin American countries, like a flock of sheep, went over to the metric system. It was just a fad and experiment and even though legally established, it has had but a scrambling use, sharing the field with the old Spanish and with the English units and measures.

While the metric system is scientifically arranged, the units of the system itself are inconvenient and impracticable, except in the laboratory. The point I tried to make in the statement before the congressional committee was that the foot constitutes a more practical and convenient base for a complete decimal system than does the meter. We have all eternity before us, and should therefore adopt a practical and convenient decimal system of measures for permanent use rather than the metric system, which after 50 years of legal definition and establishment has made no progress in the commercial and mechanical trades. The fact is that the metric system is not a decimal system.

There is no multiple as simple as ten used in the whole system. The primary division of the meter in a practical sense is not into tenths, but into centimeters or hundredths, so that the metric system is primarily a centissimal system. The real decimal system is based upon the division of the foot into tenths or decimal inches and into lines and points. This is the original system of James Watt, who is acknowledged to be the author of the idea of a decimal system of weights and measures. It is also a part of Jefferson's original plan for an American standard system of weights and measures. We adopted Jefferson's plan for the coinage. We should now complete Jefferson's project by adopting his system of weights and measures to coordinate with the decimal system of the coinage.

As far as the metric system is concerned, it is proposed in the bill to arbitrarily define the centimeter for American uses as one-third of the decimal inch, thus preserving the centimeter, the cubic centimeter, and the gram for laboratory uses and bringing these measures into aliquot relation with the new decimal system. This would give an ounce of 27 grams, or rather make the gram one-twenty-seventh of the ounce, so that the cubic centimeter and the gram would sustain the same relation to the cubic decimal inch which the cubic foot sustains to the cubic yard. That is to say, the cubic centimeter would be the cube of the third of the decimal inch. The third of the decimal inch only exceeds by ten sixty-three ten thousands of an inch the French centimeter, and as La Place and the French metricists missed the true lengths of quadrant by nearly a mile, the new American centimeter, defined as a third of the decimal inch, will be a nearer approximation to the theoretical centimeter than the present centimeter. Metric propagandists are proposing a world " ounce of 30 grams. The pending bill proposes to dispose of the whole metric controversy by defining the gram as one-twenty-seventh of the ounce and making our present ounce 27 grams for the accommodation of those who desire to use the gram and cubic centimeter in the laboratories or otherwise. The alteration of the centimeter and gram is so slight as to not be material for practical application and affords the tremendous advantage of an exact conversion into our common units.

I trust these observations will be worthy of your interest and consideration.

Yours, very truly,

SAM'L RUSSELL.

AMERICAN INSTITUTE OF WEIGHTS AND MEASURES,
New York, December 17, 1921.

Mr. SAMUEL RUSSELL,
342 Senate Office Building, Washington, D. C.

DEAR MR. RUSSELL: As promised you in Washington, I am inclosing to you herewith two copies of an article which originally appeared in the London edition of the American Machinist and was then reprinted in the New York edition of the same publication.

This article deals with the fact that according to our present law the American and British inch are identical.

Yours, very truly,

C. C. STUTZ, *Secretary.*

THE BRITISH AND THE AMERICAN INCH IDENTICAL.[1]

A REPLY TO A STATEMENT TO THE CONTRARY APPEARING IN THE EUROPEAN EDITION OF THE AMERICAN MACHINIST.

By C. C. Stutz, secretary American Institute of Weights and Measures.

Our attention has been called to some statements contained in an article written by Sir J. E. Petavel, director of the National Physical Laboratory, which recently appeared in your publication (issue of Jan. 8, 1921).

These statements are evidently based on widely circulated reports, which nevertheless are contrary to the facts. Our object in sending you this communication is to correct these erroneous impressions and thereby avoid wrong deductions.

Sir J. E. Petavel says: "In America the international meter is accepted as the primary standard of length, and the yard is defined by the relation, 39.37 inches equal 1 meter, an American inch of course being taken as one thirty-sixth part of this American yard. Now, the relation between the imperial standard yard and the international meter is 39.370113 inches equal 1 meter. Consequently the United States of America inch is longer than the inch as used in Great Britain by nearly three-millionths of an inch."

This is a great mistake. There is no difference between the inch in the United States and the inch in Great Britain.

The United States law of 1866 defines the meter in terms of the inch, the equivalent being 39.37 inches. This inch is the inch of England, which is thus made the fundamental standard of the United States by statute law, as it has been under common law since the first English settlement in 1607.

STANDARDS OF WEIGHTS AND MEASURES FIXED BY CONGRESS.

To make this perfectly clear we shall quote the law on this subject. To begin with we find the following passage in the Constitution of the United States: "The Congress shall have power to * * * fix the standard of weights and measures."

We quote the metric law as enacted by Congress July 28, 1866. (From Federal Statutes annotated, vol. 9, p. 1401.)

(11) Standard weights and measures.

SEC. 3569. (Use of the metric system authorized.) It shall be lawful throughout the United States of America to employ the weights and measures of the metric system, and no contract or dealing or pleading in any court shall be deemed invalid or liable to objection because the weights and measures expressed or referred to therein are weights and measures of the metric system.

SEC. 3570. (Authorized tables of weights and measures.) The tables in the schedule hereto annexed shall be recognized in the construction of contracts and in all legal proceedings as establishing in terms of the weights and measures now in use in the United States the equivalents of the weights and measures expressed therein in terms of the metric system, and the tables may be lawfully used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system.

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[1] From a letter to the editor, European edition, American Machinist.

Measures of length.

Metric denominations and values:	Inches.
Meter	39.37
Decimeter, 1/10 meter	3.937
Centimeter, 1/100 meter	.3937

To bring out more fully the intent of section 3570 we requote it in the following abbreviated form:

"The tables * * * shall be recognized * * * as establishing in terms of the weights and measures now in use in the United States the equivalents of the weights and measures expressed therein in terms of the metric system."

Here the "inch" is taken as fundamental, the meter being expressed in terms of the inch. Clearly the object of this law was not to change our basic units but to make the use of the metric system permissible. This is further evidenced by the title of section 3569, which reads: "Use of the metric system authorizes," and by the expression in the section reading: "It shall be lawful throughout the United States of America to employ the weights and measures of the metric system."

The difference to which Sir J. E. Petavel refers is merely a difference between the bars used for comparison and results from the Mendenhall order of 1893 by which the reciprocal 3600/3937 of the legal expression 3937/3600 was ordered for comparing United States standards (39.37 inches equal 1 meter and 36 inches equal 1 yard).

This order is quoted on page 60 of circular No. 47 of the Bureau of Standards, Washington, D. C., under the title: "The Metric Standards Adopted as Fundamental," and reads as far as given there:

"The office of weights and measures * * * will in the future regard the international prototype meter and kilogram as fundamental standards, in accordance with the act of July 28, 1866." (Order approved by the Secretary of the Treasury April 5, 1893.)

This quotation undoubtedly gives the impression that the meter is for use in America the fundamental unit, unless one gives heed to the qualifying expression "in accordance with the act of July 28, 1866."

This act of 1866 should have been quoted in full. The title given: "The metric standards adopted as fundamental" is therefore incorrect. This order had no effect whatever on the legal length of the inch and yard. As pointed out previously, standards of weights and measures can not be changed in the slightest degree except by act of Congress.

The United States Bureau of Weights and Measures in 1893, and its successor the Bureau of Standards, could legally conform to the Mendenhall order only so far as the bar used for comparison was concerned. Under the law and the Constitution the sworn duty of the officials of those bureaus was and is to treat any variation between standards resulting from the use of the reciprocal (3600/3937) of the legal meter as merely a variation between bars used for comparison, just as the difference between the London yard and Sevres meter or between the different meter bars are taken into account in verifying standards.

Two facts should always be kept in mind.

(1) The United States yard and the British yard are exactly the same, and can be made to vary only by act of the British Parliament or by act of the Congress of the United States.

(2) The act of 1866 defining the meter as 39.37 inches established a United States standard meter differing slightly from the standard meter accepted by the International Bureau of Weights and Measures at Sevres.

The equivalent of the international meter is taken as 39.370113 inches in England, and as 39.370000 inches in United States of America; therefore the United States meter is shorter than the international meter, and the difference is expressed by 39370000/39370113 = .99999712902 + .00000287098 = 1.00000000000, or approximately 287/100,000 millimeter, or nearly 3/1,000 millimeter.

This question can not be settled by asserting that the differences are negligible for ordinary measurements, and are material only when the highest degree of precision is involved. The principle is as important in one case as in the other. If it is conceded that an order of a bureau official at Washington can change the United States standard of the yard to any extent whatever, no matter how slight, then the same official can change this standard or any other standard by a larger amount.

Attempts have been made in the United States through the introduction of bills in Congress to secure the acceptance of the meter as the sole United States standard by the authority of Congress, but these attempts so far have failed. An incident of this kind is recalled by the Ashbrook-Stratton-Thurman bill of 1907, framed by the United States Department of Commerce. This bill was not passed, nor have similar bills found favor.

The temperature at which a bar is declared standard is naturally of great importance. The international prototype meter is standard at 0° C. (32° F.). The imperial standard yard is standard at 62° F. There is no legal statement in the United States as to the temperature at which a yard is standard. Such a legal statement is unnecessary until a legal physical standard of length is adopted. This we do not have. No physical standard of length has ever been established by Congress. Thus, legally, we must go back to the British imperial yard at 62° F.

It is for this reason that bars on measuring machines are generally made standard at 62° F. in the United States. According to the act of 1866 both the "inch" bars and metric bars must be made standard at the same temperature, in order that the relation between English and metric measurements made on such machines under similar conditions be in accordance with that act.

SIR J. E. PETAVEL'S REPLY.

To THE EDITOR.

DEAR SIR: I have received proof of an article by Mr. C. C. Stutz, entitled "The British and American Inch Identical." I have been very interested to see this and to note the facts set forth.

I admit that we were certainly in some perplexity as to the exact position in the United States, but our conclusion was based on the statement of the Bureau of Standards circular No. 47, quoted in this article, which statement taken by itself would appear to show clearly that the meter and not the yard was accepted in America as the fundamental standard; and we believe it is a fact that the Bureau of Standards so interprets the Mendenhall order. None the less, it certainly appears from the article that this interpretation has not legal sanction, and that therefore it is the American meter and not the American inch which, in accordance with the law of 1866, must be regarded as slightly different from true standard.

Yours, faithfully,

J. E. PETAVEL, *Director.*

Teddington.

DECEMBER 20, 1921.

Mr. C. C. STUTZ,
Secretary American Institute of Weights and Measures.
New York City.

DEAR MR. STUTZ: I have your letter of December 19.

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One question that occurs to me is whether or not a new standard American foot, derived from the yard in the National Physical Laboratory at London—and not being referred officially to the meter—could be made our prototype foot, and particularly whether or not it could be said that this prototype foot was in anywise less suitable as the base of our American weights and measures than is the London or Teddington yard for the English measures. Of course, the London yard and the Washington foot would be in perfect correlation. Could the foot in any sense be regarded as too short a linear unit for the prototype?

I have already spoken to you about the magnitude of the ounce and of its correlated fluid ounce or decimal cube as being suitable mass and volume units for use in chemistry, assuming, of course, that these units would be standardized and made internationally as definite as grams and cubic centimeters. Is there anything in the volume of the cubic centimeter or in the weight of the gram which makes them serve a purpose in chemistry which can not be equally served by the ounce and fluid ounce or decimal cube?

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Very truly, yours,

SAM'L RUSSELL.

(Thereupon, at 11.30 o'clock a. m., the subcommittee adjourned subject to the call of the chairman.)

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